CLAIMS

WHAT IS CLAIMED IS:

1. Ultrasonic bone testing apparatus comprising a pair of ultrasonic transducers at least one of which comprises a piezoelectric copolymer; mounting structure supporting the transducers in facing spaced relation to each other, so as to be respectively positionable on opposite sides of and both coupled ultrasonically to an animal portion containing a bone, for respectively transmitting ultrasonic energy through and receiving ultrasonic energy transmitted through said animal portion including the bone; and electrical circuitry connected to the transducers to energize one transducer to transmit ultrasonic energy and to detect an electrical signal generated by the other transducer in response to received ultrasonic energy.

2. Apparatus as defined in claim 1, wherein the mounting structure includes a support for positioning the animal portion between the transducers, and a device for coupling the transducers ultrasonically to the animal portion; and wherein each of the transducers comprises a piezoelectric copolymer transducer.

3. Apparatus as defined in claim 2, wherein each of the transducers comprises a copolymer disk having a periphery and two opposed major surfaces, one of which is disposed to face the bone-containing animal portion, and further includes rigid support structure engaging the other major surface of the disk inwardly of the periphery thereof for supporting the disk against pressure exerted on the first-mentioned major surface of the disk.

4. Apparatus as defined in claim 2, wherein said coupling device comprises a pair of pads, respectively disposed in contact with said transducers, and respectively engageable with opposed surface regions of an animal portion positioned in said support as aforesaid.

5. Apparatus as defined in claim 4, wherein each of said transducers comprises a copolymer disk having a periphery and opposed major surfaces, one of which is in contact with one of said pads, and further includes rigid support structure engaging the other major surface of the disk inwardly of the periphery thereof for supporting the disk against pressure exerted on the disk through the last-mentioned pad.

6. Apparatus as defined in claim 2, wherein said coupling device includes a container for holding a body of a coupling fluid in which the animal portion is immersed when positioned by the support as aforesaid and with which said transducers are in ultrasonic energy transmitting contact.

7. Apparatus as defined in claim 2, in which the animal portion is a human heel containing a calcaneal bone, said support positioning said heel, and said transducers and coupling device being disposed, so that ultrasonic energy transmitted from said one transducer to said other transducer passes through the calcaneal bone.

8. Apparatus as defined in claim 2, in which said electrical circuitry is arranged to use the detected electrical signal for deriving a value representative of the speed of sound through the bone through which the ultrasonic energy is transmitted as aforesaid.

9. Apparatus as defined in claim 2, in which said electrical circuitry is arranged to use the detected electrical signal in deriving a value representative of broadband ultrasonic attenuation in the bone through which the ultrasonic energy is transmitted as aforesaid.

10. A method of determining a characteristic of a bone in a bone-containing portion of an animal comprising disposing a pair of ultrasonic transducers at least one of which comprises a piezoelectric copolymer respectively on opposite sides of, and

ultrasonically coupling both transducers to, a bone-containing animal portion; electrically energizing one transducer to transmit ultrasonic energy through the animal portion including the bone, such that the transmitted ultrasonic energy is received and converted to an electrical signal by the other transducer; detecting the electrical signal; and using the detected signal to derive a value representative of the bone characteristic to be determined.

11. A method according to claim 10 wherein each of the transducers is a disk of piezoelectric copolymer.

12. A method according to claim 11, wherein each transducer disk has a periphery and opposed major surfaces, one of which is oriented to face the animal portion, and further including supporting the other major surface of each disk by disposing, in contact therewith, rigid support structure spaced inwardly from the disk periphery.

13. Apparatus as defined in claim 1, wherein at least one of said transducers is a piezoelectric copolymer transducer having a curved surface for focusing.

14. Apparatus as defined in claim 1, wherein at least one of said transducers is a copolymer array transducer.

15. A method according to claim 10, wherein at least one of said transducers is a copolymer array transducer.

16. A method according to claim 15, wherein the step of deriving a value includes correcting for phase cancellation.

17. A method according to claim 15, wherein the step of deriving a value includes producing an image.

18. Ultrasonic bone testing apparatus comprising a pair of ultrasonic transducers at least one of which comprises a

poly(vinylidene fluoride-trifluoroethylene) copolymer; mounting structure supporting the transducers in facing spaced relation to each other, so as to be respectively positionable on opposite sides of and both coupled ultrasonically to an animal portion containing a bone, for respectively transmitting ultrasonic energy through and receiving ultrasonic energy transmitted through said animal portion including the bone; and electrical circuitry connected to the transducers to energize one transducer to transmit ultrasonic energy and to detect an electrical signal generated by the other transducer in response to received ultrasonic energy.

19. Apparatus as defined in claim 18, wherein said one transducer is an array transducer.

20. Apparatus as defined in claim 19, wherein said one transducer is a transducer for transmitting ultrasonic energy as aforesaid.

21. Apparatus as defined in claim 19, wherein said one transducer is a transducer for receiving ultrasonic energy as aforesaid.

22. Apparatus as defined in claim 18, wherein each of said transducers is an array transducer comprising a poly(vinylidene fluoride-trifluoroethylene) copolymer.

23. A method of determining a characteristic of a bone in a bone-containing portion of an animal comprising disposing a pair of ultrasonic transducers at least one of which comprises a poly(vinylidene fluoride-trifluoroethylene) copolymer respectively on opposite sides of, and ultrasonically coupling both transducers to, a bone-containing animal portion; electrically energizing one transducer to transmit ultrasonic energy through the animal portion including the bone, such that the transmitted ultrasonic energy is received and converted to an electrical signal by the other transducer; detecting the electrical signal;

and using the detected signal to derive a value representative of the bone characteristic to be determined.

24. Apparatus as defined in claim 1, wherein the mounting structure includes a support for positioning the animal portion between the transducers, and a device for coupling the transducers ultrasonically to the animal portion.

25. An osteoporosis apparatus for measuring ultrasonic characteristic(s) of a patient's bone, the apparatus comprising:

(a) two ultrasonic transducers spacedly positioned in respective heads in the apparatus for ultrasonic transmission from a first of the transducers to the other, at least one of said transducers comprising a piezoelectric copolymer;

(b) circuitry for controlling transmission from the first transducer, measuring the reception at the other and providing an output indicative of the ultrasonic characteristic(s);

(c) two diaphragms positioned in the respective heads;

(d) structural spacing means that permits the diaphragms to be brought in contact with the patient's bone so that there is a fluid path from each transducer to its diaphragm and a gap between the diaphragms which is occupied in use by the patient's bone; and

(e) a fluid system connecting the diaphragms and adapted to be pressurized for adjustment of the diaphragms by inflation against the patient's bone.

26. Apparatus as defined in claim 25, wherein at least said one transducer is a copolymer array transducer.

27. Apparatus as defined in claim 26, wherein each of said transducers is a copolymer array transducer.

28. Apparatus as defined in claim 25, wherein said fluid system contains a fluid having a speed of sound substantially invariant with temperature.